Installation and Operations Manual

Enphase Microinverter Models M190™ and M210™

Contact Information

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FCC Compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance may void the user's authority to operate the equipment.

Other Information

Product information is subject to change without notice. All trademarks are recognized as the property of their respective owners.

For Enphase Envoy Warranty Terms and Conditions, see the Appendix on page 22 of this manual.

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Important Safety Information

Read this First

This manual contains important instructions to follow during installation and maintenance of the Enphase Microinverter. User documentation is updated frequently; Check the Enphase website (http://www.enphaseenergy.com/support/downloads) **for the latest information.**

To reduce the risk of electrical shock, and to ensure the safe installation and operation of the Enphase Microinverter, the following safety symbols appear throughout this document to indicate dangerous conditions and important safety instructions.

WARNING! This indicates a situation where failure to follow instructions may be a safety hazard or cause equipment malfunction. Use extreme caution and follow instructions carefully.

NOTE: This indicates information particularly important for optimal system operation. Follow instructions closely.

Safety Instructions

WARNING: Be aware that the body of the Enphase Microinverter is the heat sink. Under normal operating conditions, the temperature is 15°C above ambient, but under extreme conditions the microinverter can reach a temperature of 80°C. To reduce risk of burns, use caution when working with the microinverters.

- Perform all electrical installations in accordance with all local electrical codes and the National Electrical Code (NEC), ANSI/NFPA 70.
- Be aware that only qualified personnel should install and/or replace Enphase Microinverters.
- Do not attempt to repair the Enphase Microinverter; it contains no user-serviceable parts. If it fails, please contact Enphase customer service to obtain an RMA number and start the replacement process. Tampering with or opening the Enphase Microinverter will void the warranty.
- Before installing or using the Enphase Microinverter, please read all instructions and cautionary markings in the technical description and on the Enphase Microinverter system and the PV-array.
- Connect the Enphase Microinverter to the electrical utility grid only after receiving prior approval from the utility company.
- Do NOT disconnect the PV module from the Enphase Microinverter without first removing AC power.

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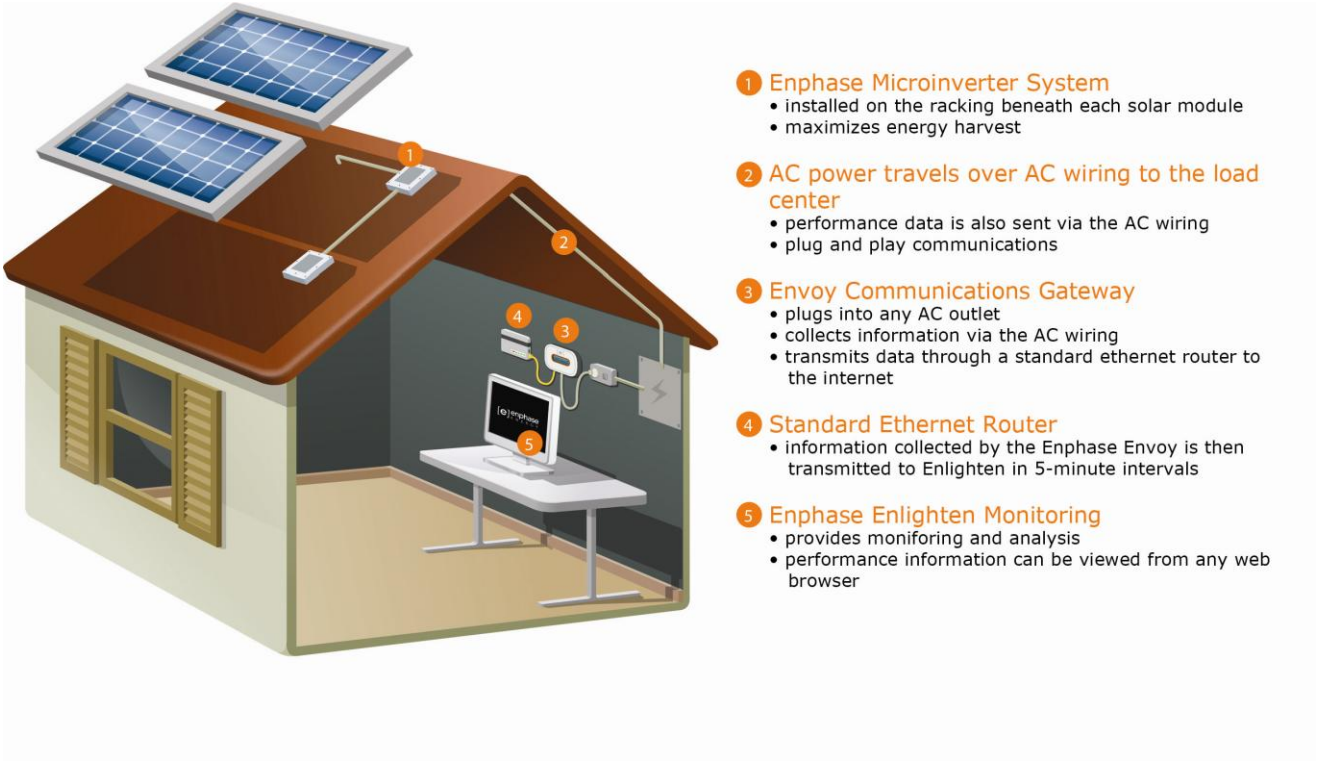
The Enphase Microinverter System

The Enphase Microinverter System is the world's most technologically advanced inverter system for use in utility-interactive applications. This manual details the safe installation and operation of the Enphase Microinverter.

The three key elements of an Enphase Microinverter System are:

- the Enphase Microinverter
- the Enphase Envoy™ Communications Gateway
- the Enphase Enlighten™ web-based monitoring and analysis system

This integrated system maximizes energy harvest, increases system reliability, and simplifies design, installation and management.


1 Enphase Microinverter System
• installed on the racking beneath each solar module
• maximizes energy harvest
2 AC power travels over AC wiring to the load center
• performance data is also sent via the AC wiring
• plug and play communications
3 Envoy Communications Gateway
• plugs into any AC outlet
• collects information via the AC wiring
• transmits data through a standard ethernet router to the internet
4 Standard Ethernet Router
• information collected by the Enphase Envoy is then transmitted to Enlighten in 5-minute intervals
5 Enphase Enlighten Monitoring
• provides moniforing and analysis
• performance information can be viewed from any web browser

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How the Microinverter Works

The Enphase Microinverter maximizes energy production from your photovoltaic (PV) array. Each Enphase Microinverter is individually connected to one PV module in your array. This unique configuration means that an individual Maximum Peak Power Point Tracker (MPPT) controls each PV module. This insures that the maximum power available from each PV module is exported to the utility grid regardless of the performance of the other PV modules in the array. That is, although individual PV modules in the array may be affected by shading, soiling, orientation, or module mismatch, the Enphase Microinverter insures top performance for its associated PV module. The result is maximum energy production from your PV system.

System Monitoring

Indoors, you can install the Envoy Communications Gateway by plugging it into any convenient 120Vac wall socket and providing an Ethernet connection to your broadband router or modem. After installation of the Envoy, the full network of Enphase Microinverters automatically begins reporting to the Enphase Enlighten web server. The Enlighten software presents current and historical system performance trends, and it informs you when the PV system is not performing as expected.

Optimal Reliability

Microinverter systems are also inherently more reliable than centralized or string inverters. The distributed nature of a microinverter system ensures that there is no single point of system failure in the PV system. Enphase Microinverters are designed to operate at full power at ambient temperatures as high as 65°C (150°F). The microinverter housing is designed for outdoor installation and complies with the NEMA 6 environmental enclosure rating standard:

> NEMA 6 rating definition: Indoor or outdoor use primarily to provide a degree of protection against hose-directed water, and the entry of water during occasional temporary submersion at a limited depth, and damage from external ice formation.

Ease of Design

PV systems using Enphase Microinverters are very simple to design and install. You will not need string calculations, and you can install individual PV modules in any combination of module quantity, type, age and orientation. You won't need to install cumbersome centralized or string inverters. Each microinverter quickly mounts on the PV racking, directly beneath each PV module. Low voltage DC wires connect from the PV module directly to the co-located microinverter, eliminating the risk of personnel exposure to lethal 600Vdc power.

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Enphase Microinverter Models M190™ and M210™

The Enphase M190 microinverters are **electrically** compatible with most 60 and 72 cell PV modules. The M210 microinverters are **electrically** compatible with most 72 and 84 cell PV modules. For more information, see the Technical Data section on page 19 of this manual.

Refer to the Enphase website (http://www.enphaseenergy.com/support/downloads) for a list of **electrically** compatible PV modules and approved PV module racking systems. To ensure **mechanical** compatibility, be sure to order the correct connector type for both microinverter and PV module from your distributor.

See the Enphase website (http://www.enphaseenergy.com/support/downloads.cfm) for a list of approved PV module racking systems.

The following table summarizes **electrical** compatibility.

Model Number	Works with PV Module Type	Maximum Microinverters per AC branch circuit	Module Connector Type	Works with Service Type
M190-72-208-S12 M190-72-208-S12-NA	60 and 72 cell	21	MC-4 Type 2 Locking or Amphenol H4 Locking	208 VAC Three Phase
M190-72-208-S13 M190-72-208-S13-NA	60 and 72 cell	21	Tyco Solarlok Locking	208 VAC Three Phase
M190-72-240-S12 M190-72-240-S12-NA	60 and 72 cell	15	MC-4 Type 2 Locking or Amphenol H4 Locking	240 VAC Single Phase
M190-72-240-S13 M190-72-240-S13-NA	60 and 72 cell	15	Tyco Solarlok Locking	240 VAC Single Phase
M210-84-208-S12	72 and 84 cell	18	MC-4 Type 2 Locking or Amphenol H4 Locking	208 VAC Three Phase
M210-84-240-S12	72 and 84 cell	13	MC-4 Type 2 Locking or Amphenol H4 Locking	240 VAC Single Phase

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Enphase Microinverter Installation

Follow all safety instructions listed on page 4 while installing the Enphase M190 and M210 Microinverters.

WARNING: Be aware that installation of this equipment includes risk of electric shock. Normally grounded conductors may be ungrounded and energized when a ground fault is indicated.

Parts Included

In addition to the microinverters, PV modules, racking, and associated hardware, you'll need the microinverter installation kit. This kit includes the following items:

- Protective end cap
- Mounting Bracket (adapter plate)
- AC interconnect cable, 6 foot length

Other Parts and Tools Required

In addition to your PV array and its associated hardware, you will need to provide the following:

- Junction box
- Continuous grounding conductor, grounding washers
- Number 2 Phillips screwdriver
- Sockets, wrenches for mounting hardware
- Torque wrench
- Mounting hardware suitable for module racking

Lightning Surge Suppression

Lightning does not actually need to strike the equipment or building where PV system is installed to cause damage. Often, a strike nearby will induce voltage spikes in the electrical grid that can damage equipment. Enphase Energy Microinverters have integral surge protection, greater than most string inverters. However, if the surge has sufficient energy, the protection built into the Microinverter can be exceeded, and the equipment can be damaged.

Since the Enphase Limited Warranty does not cover "acts of God" such as lightning strikes, and since lightning strikes can occur anywhere, it is best practice to install surge protection as part of any solar installation. We recommend the following protection device. It has been tested to ensure that it does not interfere with power line communications. Install per vendor instructions.

Vendor: Citel
Part Number: DS72RS-120
Application: Residential 120/240V Split Phase where N-G bond exists.

See the vendor datasheet for DS70R, (which includes the DS72RS-120) at http://www.citelprotection.com/english/citel_data_sheets/ac_protection/.

For commercial sites, contact Citel at http://www.citelprotection.com/ for information on a unit to fit your needs.

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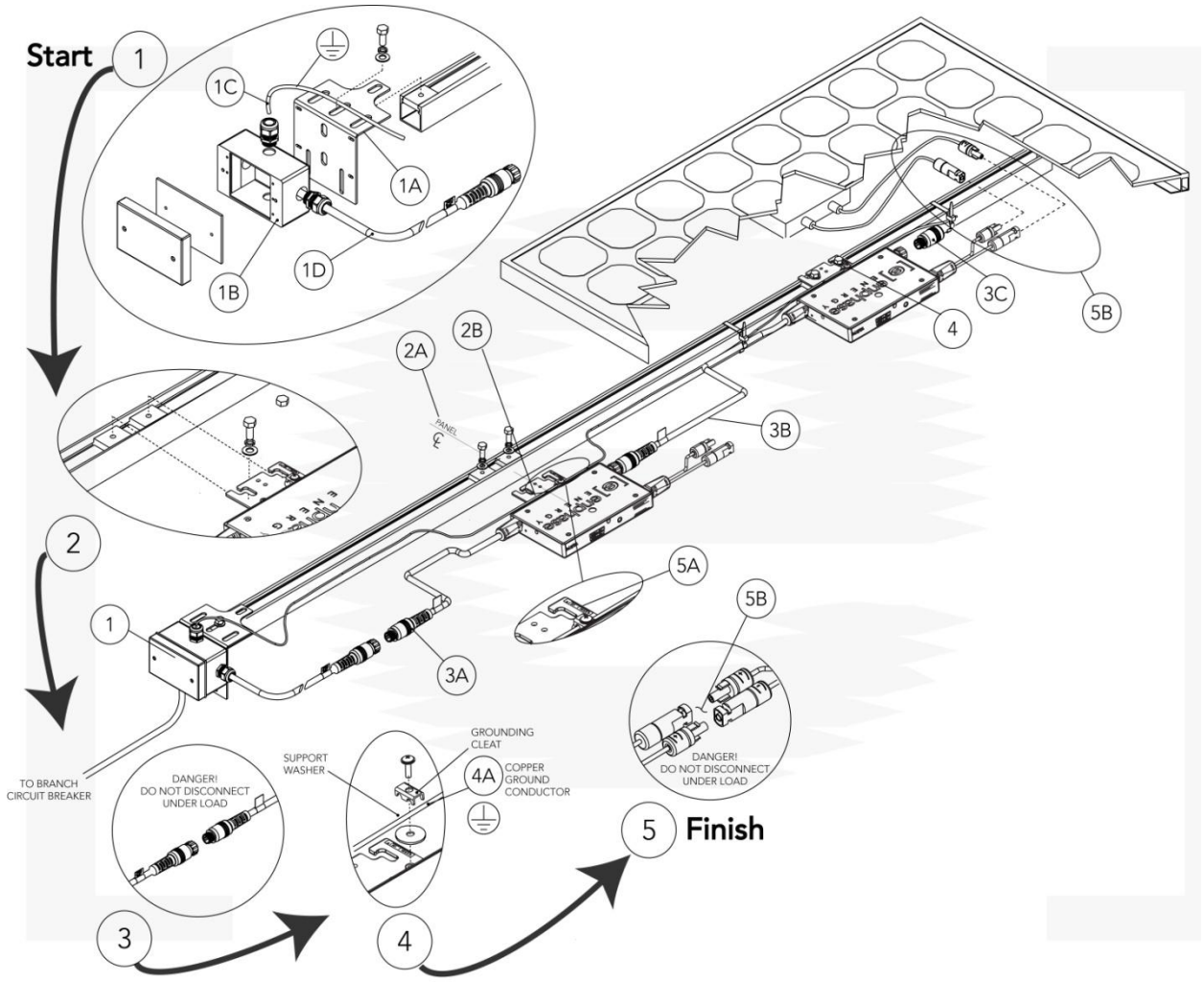
Installation Procedure

Installing the Enphase Microinverter System involves several key steps:

1. Measuring service and Installing the AC branch circuit junction box
2. Attaching the Enphase Microinverters to the racking
3. Connecting the Enphase Microinverter wiring harnesses
4. Grounding the system
5. Completing the Enphase installation map and Connecting the PV modules

Each of the detailed installation steps in the following sections is numerically referenced in the installation diagram below.

WARNING: DO NOT connect Enphase Microinverters to the utility grid or energize the AC circuit(s) until you have completed all of the installation procedures as described in the following sections.



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Step 1 - Install the AC Branch Circuit Junction Box

1. Measure service entrance conductors to confirm AC service at the site. Acceptable ranges are shown in the table below:

240 Volt AC Single Phase		208 Volt AC 3 Phase	
L1 to L2	211 to 264 Vac	L1 to L2 to L3	183 to 229 Vac
L1, L2 to neutral	106 to 132 Vac	L1, L2, L3 to neutral	106 to 132 Vac

2. Mount the Enphase Adapter Plate at a suitable location on the PV racking system (typically at the end of a row of modules).
3. Install an appropriate junction box with adapter plate.

WARNING: Only use electrical system components approved for wet locations.

4. Connect the open wire end of the Enphase AC interconnect cable into the junction box using an appropriate gland or strain relief fitting. The AC interconnect cable requires a strain relief connector with an opening of 3/8 inches in diameter.

Step 2 - Attach the Microinverters to the Racking

a. Mark the approximate centers of each PV module on the racking system. Evaluate the location of the microinverter with respect to the PV module junction box or any other obstructions.

WARNING: Allow a minimum of .75 inches between the top of the roof and the bottom of the microinverter. We also recommend that you allow .50 inches between the back of the PV module and the top of the inverter. Do not mount the microinverter in a location that allows long-term exposure to direct sunlight.

b. If using grounding washers (e.g., WEEB) to ground the microinverter chassis to the PV module racking, choose a grounding washer that is approved for the racking manufacturer. Install a minimum of one grounding washer per microinverter. Torque the microinverter fasteners to the values listed below.

- 1/4" mounting hardware – 45 inlbs minimum
- 5/16" mounting hardware – 80 inlbs minimum

Compatible grounding washer part numbers are included in the Racking Compatibility Application Note. Installation guidelines are included in the Grounding Washer Application Note. Refer to both documents at: http://www.enphaseenergy.com/support/downloads.cfm

c. Mount one microinverter at each of these locations using hardware recommended by your module racking vendor. Mounting slots on the microinverter are 0.33 inches in diameter. Maximum bolt size is 5/16 inch. The two slots on the microinverter are 4 inches apart.

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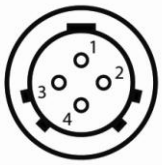
Step 3 - Connect the Microinverter Wiring Harnesses

Each microinverter comes with one 4-pin bulkhead receptacle (or short pigtail) and one 70-inch AC wire harness with multi-pin connectors. (The DC input wires are approximately six inches long and are terminated with single pole connectors.) The AC connectors are oppositely sexed, so that multiple inverters can be connected to form one continuous AC branch circuit. When you perform this step, refer to the wiring diagram for your microinverter model. These diagrams are located in the Appendix of this manual.

a. Orient the first microinverter in each branch with its male connector facing the junction box. The junction box AC interconnect cable has a female connector. The microinverter can be mounted with either side facing up to accommodate cable routing. Connect the first microinverter to the AC interconnect cable. All AC interconnect cables have four conductors. Wire them as follows depending on your microinverter model:

240 VOLT AC SPLIT PHASE WIRING	208 VOLT AC THREE PHASE WIRING			
BLACK - L1	BLACK - L1			PIN 1 - BLACK
RED - L2	RED - L2			PIN 2 - BLUE
ORANGE-UNUSED	ORANGE-L3			PIN 3 - RED
BLUE- NEUTRAL	BLUE- NEUTRAL			PIN 4 - ORANGE

b. Plug the AC connector of the first microinverter into the connector of the next microinverter, and so forth, to form a continuous AC branch circuit. Please check the microinverter rating label for the maximum allowable number of microinverters on one AC branch circuit.

NOTE: The AC and DC connectors of each microinverter have been evaluated and approved for use as the load break disconnect as required by the NEC.

WARNING: Do NOT exceed the maximum number of microinverters in an AC branch circuit, as displayed on the unit-rating label. Each microinverter AC branch circuit must be sourced from a dedicated branch circuit protected by a 15A maximum breaker.

c. Install a protective end cap on the open AC connector of the last microinverter in the AC branch circuit.

WARNING: Make sure protective end caps have been installed on all unused AC connectors. Unused AC microinverter wire harness connectors are live when the system is energized by the utility system.

WARNING: Size the AC wire gauge to account for voltage drop. All components of system wiring must be considered, including internal voltage drop within the length of ETD cabling. Use the voltage drop charts at: http://www.enphaseenergy.com/support/downloads.cfm to select the correct wire size based on the distance from the beginning of the microinverter branch circuit to the breaker in the load center. NEC guidelines for voltage

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drop on feeder and branch circuit conductors will not be adequate for microinverter branch circuits that contain the maximum allowable microinverters. Refer also to our *Voltage Drop Calculations Application Note* at http://www.enphaseenergy.com/support/downloads.cfm.

Step 4 – Ground the System

If you are not using grounding washers to ground the microinverter chassis as described in step 2, follow the step below. Each Enphase Microinverter comes with a ground clip that can accommodate a 6-8 AWG conductor.

a. Route a continuous GEC through each of the microinverters to the NEC approved AC grounding electrode. The racking and module could be grounded to this conductor using a crimp connection. An alternative method would be to connect the microinverter to the grounded racking using a grounding washer approved for the racking.

NOTE: The AC output neutral is not bonded to ground inside the microinverter.

Step 5 – Complete the Map and Connect the PV Modules

The Enphase Installation Map is a diagrammatic representation of the physical location of each microinverter in your PV installation. The virtual array in Enlighten is created from the map you create. Use the blank map in the Appendix to record microinverter placement for the system, or provide your own layout if a larger or more intricate installation map is required.

Complete the Enphase Map

a. Each Enphase Microinverter has a removable serial number label located on the mounting plate. Peel the removable serial number label from each Enphase Microinverter and affix it to the respective location on the Enphase installation map (see map on page 24). You can also download installation maps and examples from www.enphaseenergy.com/quickstart. Remember to keep a copy of the installation map for your records.

Alternative: Create Your Own Map

a. Draw a top-down view of the array using the Array Map template (using either the grid on Side A or the freeform area on Side B). Make sure to leave enough room to place the serial number stickers.

b. When installing the microinverters, remove the serial number labels located next to the DC input cables and place them in the correct order on your drawing of the system. Remember to keep a copy of the installation map for your records.

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Connect the PV Modules

NOTE: Completely install all microinverters and all system inter-wiring connections prior to installing the PV modules.

a. Mount the PV modules above their corresponding microinverters. Each microinverter comes with two oppositely sexed DC connectors.

b. First connect the positive DC wire from the PV module to the negatively marked DC connector (male pin) of the microinverter. Then connect the negative DC wire from the PV module to the positively marked DC connector (female socket) of the microinverter. Repeat for all remaining PV modules using one microinverter for each module.

Step 6 – Build the Virtual Array

In this step, you will create the virtual array in Enlighten from the map you created in the last step. Once the virtual array is built, Enlighten displays a graphic representation of the PV system. It also shows detailed current and historical performance information. Please go to www.enphaseenergy.com for more information on the Enphase Enlighten web-based monitoring and analysis.

a. Use Array Builder to create the virtual array in Enlighten.

NOTE: Go to http://www.enphaseenergy.com/support/learningcenter.cfm to view an Array Builder demo.

b. If you do not already have an account, please go to http://www.enphaseenergy.com for more information on the Enphase Enlighten web-based monitoring and analysis.

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Commissioning

WARNING: Connect the Enphase Microinverter to the electrical utility grid only after receiving prior approval from the utility company.

WARNING: Be aware that only qualified personnel must connect the Enphase Microinverter to the electrical utility grid.

WARNING: Ensure that all AC and DC wiring is correct. Ensure that none of the AC and DC wires are pinched or damaged. Ensure that all junction boxes are properly closed.

NOTE: The Status LED of each microinverter will blink green six times to indicate normal start-up operation **one minute after DC power is applied**.

To commission the Enphase Microinverter PV system:

1. Turn ON the AC disconnect or circuit breaker on each microinverter AC branch circuit.
2. Turn ON the main utility-grid AC circuit breaker. Your system will start producing power **after a five-minute wait time**.
3. The Enphase Microinverters will start to send performance data over the power lines to the Envoy. The time required for all the microinverters in the system to report to the Envoy will vary with the number of microinverters in the system. The first units should be detected within 15 minutes but the entire system could take hours to detect. Please refer to the *Envoy Installation and Operation Manual* for information on the Envoy.

Operating Instructions

The Enphase microinverter is powered on when sufficient DC voltage from the module is applied. The status LED will flash green six times one minute after DC power is applied. These green blinks indicate proper start–up.

NOTE: In the event of a GFDI failure, the status LED will display continuous red after the fault occurs. This will persist when AC and DC power are cycled to the microinverter. Refer to page 16 for information on troubleshooting a GFDI condition.

You can also verify proper operation of the Enphase Microinverters via the Envoy. See the *Envoy Communications Gateway Installation and Operation Manual* for more information.

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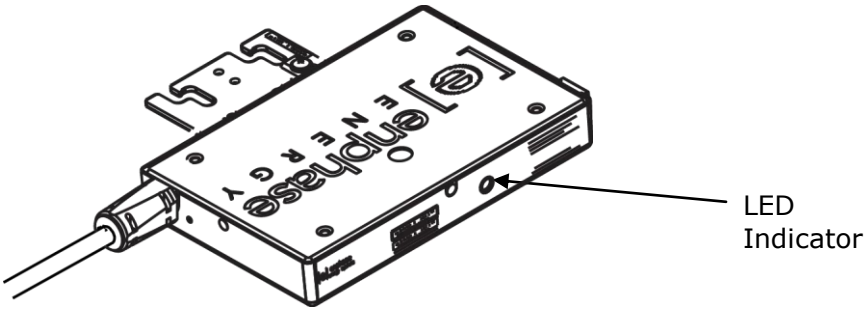
Troubleshooting

Adhere to all the safety measures described throughout this manual. Qualified personnel can use the following troubleshooting steps if the PV system does not operate correctly.

WARNING: Do not attempt to repair the Enphase Microinverter; it contains no user-serviceable parts. If it fails, please contact Enphase customer service to obtain an RMA number and start the replacement process.

Status LED Indications and Error Reporting

Each Enphase microinverter has an LED that indicates status as follows:



Startup LED Operation:

One minute after DC power is first applied to the microinverter, six short green blinks indicate a successful microinverter startup sequence.

Six short red blinks after DC power is first applied to the microinverter indicate a failure during microinverter startup.

Post-Startup LED Indications:

Flashing Green – Producing power and communicating with Envoy
Flashing Orange – Producing power and not communicating with Envoy
Flashing Red – Not producing power

GFDI Fault:

A solid red status LED when DC power has been cycled, indicates the microinverter has detected a ground fault (GFDI) error. The LED will remain red and the fault will continue to be reported by the Envoy until the error has been cleared.

The condition should clear with operator intervention, unless conditions causing the event have not been remedied or if the failure is permanent. Follow the instructions in the *Envoy Communications Gateway Installation and Operation Manual* to clear this condition. Or, for assistance, contact Enphase Energy customer support at support@enphaseenergy.com.

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Other Faults:

All other faults are reported to the Envoy. Refer to the *Envoy Installation and Operation Manual* for a list of additional faults and troubleshooting procedures.

WARNING: Be aware that only qualified personnel should troubleshoot the PV array or the Enphase Microinverter.

WARNING: Never disconnect the DC wire connectors under load. Ensure that no current is flowing in the DC wires prior to disconnecting. An opaque covering may be used to cover the module prior to disconnecting the module.

WARNING: Always disconnect AC power before disconnecting the PV module wires from the Enphase Microinverter. The AC connector of the first microinverter in a branch circuit is suitable as a disconnecting means once the AC branch circuit breaker in the load center has been opened.

WARNING: The Enphase Microinverters are powered by DC power from the PV modules. Make sure you disconnect the DC connections and reconnect DC power to watch for the six short LED blinks one minute after DC is applied.

Troubleshooting an Inoperable Microinverter

To troubleshoot an inoperable microinverter, follow the steps in the order shown:

1. Check the connection to the utility grid. Verify that the utility voltage and frequency are within allowable ranges shown in the Technical Data section on page 19 of this manual.
2. Verify utility power is present at the inverter in question by removing AC, then DC power. **Never disconnect the DC wires while the microinverter is producing power.** Re-connect the DC module connectors. After one minute, watch for six short LED blinks.
3. Check the AC branch circuit interconnection harness between all the microinverters. Verify that each inverter is energized by the utility grid as described in the previous step.
4. Make sure that any AC disconnects are functioning properly and are closed.
5. Verify the PV module DC voltage is within the allowable range shown in the Technical Data section on page 19 of this manual.
6. Check the DC connections between the microinverter and the PV module.
7. If the problem persists, please call customer support at Enphase Energy.

WARNING: Do not attempt to repair the Enphase Microinverter; it contains no user-serviceable parts. If troubleshooting methods fail, please return the microinverter to your distributor for maintenance.

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Disconnecting a Microinverter from the PV Module

To ensure the microinverter is not disconnected from the PV modules under load, adhere to the following disconnection steps in the order shown:

1. Disconnect the AC by opening the branch circuit breaker.
2. Disconnect the first AC connector in the branch circuit.
3. Cover the module with an opaque cover.
4. Using a DC current probe, verify there is no current flowing in the DC wires between the PV module and the microinverter.
5. Care should be taken when measuring DC currents, most clamp-on meters must be zeroed first and tend to drift with time.
6. Disconnect the PV module DC wire connectors from the microinverter.
7. Remove the microinverter from the PV array racking.

Installing a Replacement Microinverter

1. Attach the replacement microinverter to the PV module racking using hardware recommended by your module racking vendor. If you are using grounding washers (e.g., WEEB) to ground the chassis of the microinverter, the old grounding washer should be discarded, and a new grounding washer must be used when installing the replacement microinverter. Torque the microinverter fasteners to the values listed below:
   - 1/4" mounting hardware – 45 in-lbs minimum
   - 5/16" mounting hardware – 80 in-lbs minimum
2. If you are using a grounding electrode conductor to ground the microinverter chassis, attach the grounding electrode conductor to the microinverter ground clamp.
3. Connect the AC cable of the replacement microinverter and the neighboring microinverters to complete the branch circuit connections.
4. Energize the branch circuit breaker, and verify operation of the replacement microinverter by checking the indicator light.
5. Initiate a device scan at the Envoy. To do this, press and hold the Menu button on Envoy for two seconds to bring up the Envoy menu on the LCD window. When the LCD window displays "Enable Communication Check", release the Menu button.
6. Use Enlighten's Array Builder function to add the newly detected microinverter to the virtual array.

NOTE: Go to http://www.enphaseenergy.com/support/learningcenter.cfm to view an Array Builder demo.

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Technical Data

Technical Considerations

Be sure to verify the voltage and current specifications of your PV module match with those of the microinverter. For more information, refer to the Enphase website (http://www.enphaseenergy.com/support/downloads.cfm) for a list of electrically compatible PV modules and approved racking systems.

WARNING: You must match the DC operating voltage range of the PV module with the allowable input voltage range of the Enphase Microinverter.

WARNING: The maximum open circuit voltage of the PV module must not exceed the specified maximum input voltage of the Enphase Microinverter.

The output voltage and current of the PV module depends on the quantity, size and temperature of the PV cells, as well as the solar insolation on each cell. The highest PV module output voltage occurs when the temperature of the cells is the lowest and the module is at open circuit (not operating). The maximum short circuit current rating of the module must be equal to or less than the maximum input DC short circuit current rating of the microinverter. See the Enphase website (http://www.enphaseenergy.com/support/downloads.cfm) to view a list of compatible PV modules.

Technical Specifications

Enphase Microinverter Operating Parameters				
Topic/Model	**Unit**	**Min**	**Typical**	**Max**
DC Operating Parameters				
MPPT voltage range				
M190 models	V	22		40
M210 models	V	31		50
Maximum DC input voltage				
M190 models	V			56
M210 models	V			62
DC Start Voltage				
M190 models	V	28		54
M210 models	V	38		62
Maximum DC input short circuit current				
M190 models	A			12
M210 models	A			12
Maximum DC input current				
M190 models	A			10
M210 models	A			10
Ground fault protection	mA			1000
Maximum input source backfeed current to input source	A			0

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Enphase Microinverter Operating Parameters				
Topic/Model	**Unit**	**Min**	**Typical**	**Max**
AC Operating Parameters				
Maximum AC output Power (-40 to 65 °C)				
M190 models	W	190		
M210 models	W	210		
Output power factor		0.95	0.99	1
Nominal AC output voltage range				
M190-72-240-S1x	Vrms	211	240	264
M190-72-208-S1x	Vrms	183	208	229
M210-84-240-S1x	Vrms	211	240	264
M210-84-208-S1x	Vrms	183	208	229
Extended AC output voltage range				
M190-72-240-S1x	Vrms	206	240	269
M190-72-208-S1x	Vrms	179	208	232
M210-84-240-S1x	Vrms	206	240	269
M210-84-208-S1x	Vrms	179	208	232
Maximum AC output current				
M190-72-240-S1x	mA		800	900
M190-72-208-S1x	mA		920	1040
M210-84-240-S1x	mA		880	995
M210-84-208-S1x	mA		1000	1147
Nominal AC output frequency range	Hz	59.3	60	60.5
Extended AC output frequency range	Hz	59.2	60	60.6
Maximum AC output over current protection	A			15 A
Maximum AC output fault current & duration	A_p/ms	0.788Arms, over 3 cycles; 0.784Arms, over 5 cycles; 27.4Apeak, 50us duration		
High AC Voltage trip limit accuracy	%	±2.5		
Low AC Voltage Trip limit accuracy	%	±4.0		
Frequency trip limit accuracy	Hz	±0.1		
Trip time accuracy	ms	±33		
Miscellaneous Operating Parameters				
Maximum inverters per AC branch circuit				
M190-72-240-S1x		1		15
M190-72-208-S1x		1		21
M210-84-240-S12		1		13
M210-84-208-S12		1		18
Peak inverter efficiency				
M190 models	%			95.5
M210 models	%			96.0
CEC weighted efficiency				
M190 models	%			95.0
M210 models	%			95.5
Nominal MPP tracking efficiency				
M190 models	%			99.6
M210 models	%			99.6
Total Harmonic Distortion	%		2.5	5
Operating temperature range	°C	-40		65
Night Tare Loss				
M190-72-240-S1x	mW		30	
M190-72-208-S1x	mW		30	
M210-84-208-S12	mW		30	
M210-84-240-S12	mW		30	
Storage temperature range	°C	-40		65

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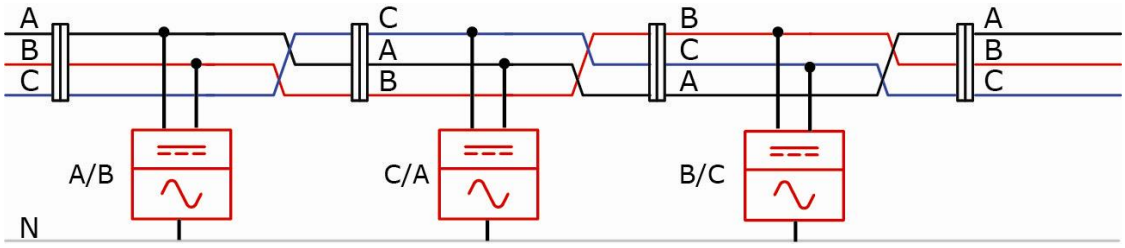
Enphase Microinverter Operating Parameters				
Topic/Model	**Unit**	**Min**	**Typical**	**Max**
Features				
Dimensions (approximate)	8” x 5 1/4” x 1 1/4”			
Weight	4.4 Lbs			
Enclosure environmental rating	NEMA 6			
Cooling	Convective – no fan			
AC Cable Rating	TC-ER, #14 AWG, Dry-rated to 90°C, UV-resistant, crush-resistant, direct burial			
DC Cable Rating	USE-2, #10 AWG			
Communication	Power line			
GFDI	A GFI sensor is internal to the microinverter and meets UL 1741.			
Standard warranty term	15 years			
Compliance	UL 1741, IEEE 1547, FCC Part 15 Class B			
Integrated AC Disconnect	The AC connector has been evaluated and approved for use as the load-break disconnect required by the NEC.			
Integrated DC Disconnect	The DC connector has been evaluated and approved for use as the load-break disconnect required by the NEC.			

Balanced 208 VAC is accomplished by alternating phases between microinverters:



Enphase Microinverter output is grid compliant according to IEEE 1547. Enphase Microinverters are required to detect and sync to the utility sine wave. For each connected phase line, the microinverter measures line to neutral voltage and frequency to ensure the utility is within acceptable limits (106 to 132 Vac).

Voltage and Frequency Limits for Utility Interaction			
Condition	Simulated utility source		Maximum time (sec) (cycles) at 60 Hz before cessation of current to the simulated utility
	Voltage (V)	Frequency (Hz)	
A	$< 0.50\ V_{Typical}$	Rated	0.16
B	$0.50\ V_{Typical} \leq V < 0.88\ V_{Typical}$	Rated	2
C	$1.10\ V_{Typical} < V < 1.20\ V_{Typical}$	Rated	1
D	$1.20\ V_{Typical} \leq V$	Rated	0.16
E	Rated	f > 60.5	0.16
F	Rated	f < (59.8 – 57.0)	0.16 – 300
G	Rated	f < 57.0	0.16

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Appendix

Limited Warranty

Enphase Energy Inc. ("**Enphase**") has developed a highly reliable microinverter that is designed to withstand normal operating conditions when used for its originally intended purpose in compliance with the Enphase User Manual supplied with the originally shipped system. The Enphase limited warranty ("**Limited Warranty**") covers defects in workmanship and materials of the Enphase microinverter ("**Defective Product**") for a period of fifteen (15) years from the date of original purchase of such microinverter at point of sale to the originally-installed end user location (the "**Warranty Period**"). During the Warranty Period, the warranty is transferable to a different owner as long as the microinverter remains installed at the originally-installed end user location.

During the Warranty Period, Enphase will, at its option, repair or replace the Defective Product free of charge, provided that Enphase through inspection establishes the existence of a defect that is covered by the Limited Warranty. Enphase will, at its option, use new and/or reconditioned parts in repairing or replacing the Defective Product. Enphase reserves the right to use parts or products of original or improved design in the repair or replacement of Defective Product. If Enphase repairs or replaces a Defective Product, the Limited Warranty continues on the repaired or replacement product for the remainder of the original Warranty Period or ninety (90) days from the date of Enphase's return shipment of the repaired or replacement product, whichever is later.

The Limited Warranty covers both parts and labor necessary to repair the Defective Product, but does not include labor costs related to un-installing the Defective Product or re-installing the repaired or replacement product. The Limited Warranty also covers the costs of shipping repaired or replacement product from Enphase, via a non-expedited freight carrier selected by Enphase, to locations within the United States (including Alaska and Hawaii) and Canada, but not to other locations outside the United States or Canada. The Limited Warranty does not cover, and Enphase will not be responsible for, shipping damage or damage caused by mishandling by the freight carrier and any such damage is the responsibility of the freight carrier.

To obtain repair or replacement service under this Limited Warranty, the customer must comply with the following policy and procedure:

- All Defective Product must be returned with a Return Merchandise Authorization Number (RMA) which customer must request from Enphase. Before requesting the RMA, however, the customer should contact an Enphase technical support representative to evaluate and troubleshoot the problem while the Enphase microinverter is in the field, since many problems can be solved in the field.
- If in-field troubleshooting does not solve the problem, Customer may request the RMA number, which request must include the following information:
    a. Proof-of-purchase of the Defective Product in the form of (1) the dated purchase receipt from the original purchase of the product at point of sale to the end user, or (2) the dated dealer invoice or purchase receipt showing original equipment manufacturer (OEM) status, or (3) the dated invoice or purchase receipt showing the product exchanged under warranty.
    b. Model number of the Defective Product
    c. Serial number of the Defective Product
    d. Detailed description of the defect
    e. Shipping address for return of the repaired or replacement product

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- All Defective Product authorized for return must be returned in the original shipping container or other packaging that is equally protective of the product
- The returned Defective Product must not have been disassembled or modified without the prior written authorization of Enphase

Enphase Microinverters are designed to withstand normal operating conditions and typical wear and tear when used for their original intent and in compliance with the installation and operating instructions supplied with the original equipment. The Limited Warranty does not apply to, and Enphase will not be responsible for, any defect in or damage to any Enphase Microinverter: (1) that has been misused, neglected, tampered with, altered, or otherwise damaged, either internally or externally; (2) that has been improperly installed, operated, handled or used, including use under conditions for which the product was not designed, use in an unsuitable environment, or use in a manner contrary to the Enphase User Manual or applicable laws or regulations; (3) that has been subjected to fire, water, generalized corrosion, biological infestations, acts of God, or input voltage that creates operating conditions beyond the maximum or minimum limits listed in the Enphase Microinverter specifications, including high input voltage from generators or lightning strikes; (4) that has been subjected to incidental or consequential damage caused by defects of other components of the solar system; or (5) if the original identification markings (including trademark or serial number) of such Microinverter have been defaced, altered, or removed. The Limited Warranty does not cover costs related to the removal, installation or troubleshooting of the customer's electrical systems. The Limited Warranty does not extend beyond the original cost of the Enphase Microinverter.

THE LIMITED WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY GIVEN BY ENPHASE AND, WHERE PERMITTED BY LAW, IS MADE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF TITLE, QUALITY, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OR WARRANTIES AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN MANUALS OR OTHER DOCUMENTATION. IN NO EVENT WILL ENPHASE BE LIABLE FOR ANY SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, COSTS OR EXPENSES HOWEVER ARISING, WHETHER IN CONTRACT OR TORT, INCLUDING WITHOUT LIMITATION ANY ECONOMIC LOSSES OF ANY KIND, ANY LOSS OR DAMAGE TO PROPERTY, OR ANY PERSONAL INJURY.

To the extent any implied warranties are required under applicable law to apply to the Enphase microinverter, such implied warranties shall be limited in duration to the Warranty Period, to the extent permitted by applicable law. Some states and provinces do not allow limitations or exclusions on implied warranties or on the duration of an implied warranty or on the limitation or exclusion of incidental or consequential damages, so the above limitation(s) or exclusion(s) may not apply. This Limited Warranty gives the customer specific legal rights, and the customer may have other rights that may vary from state to state or province to province.

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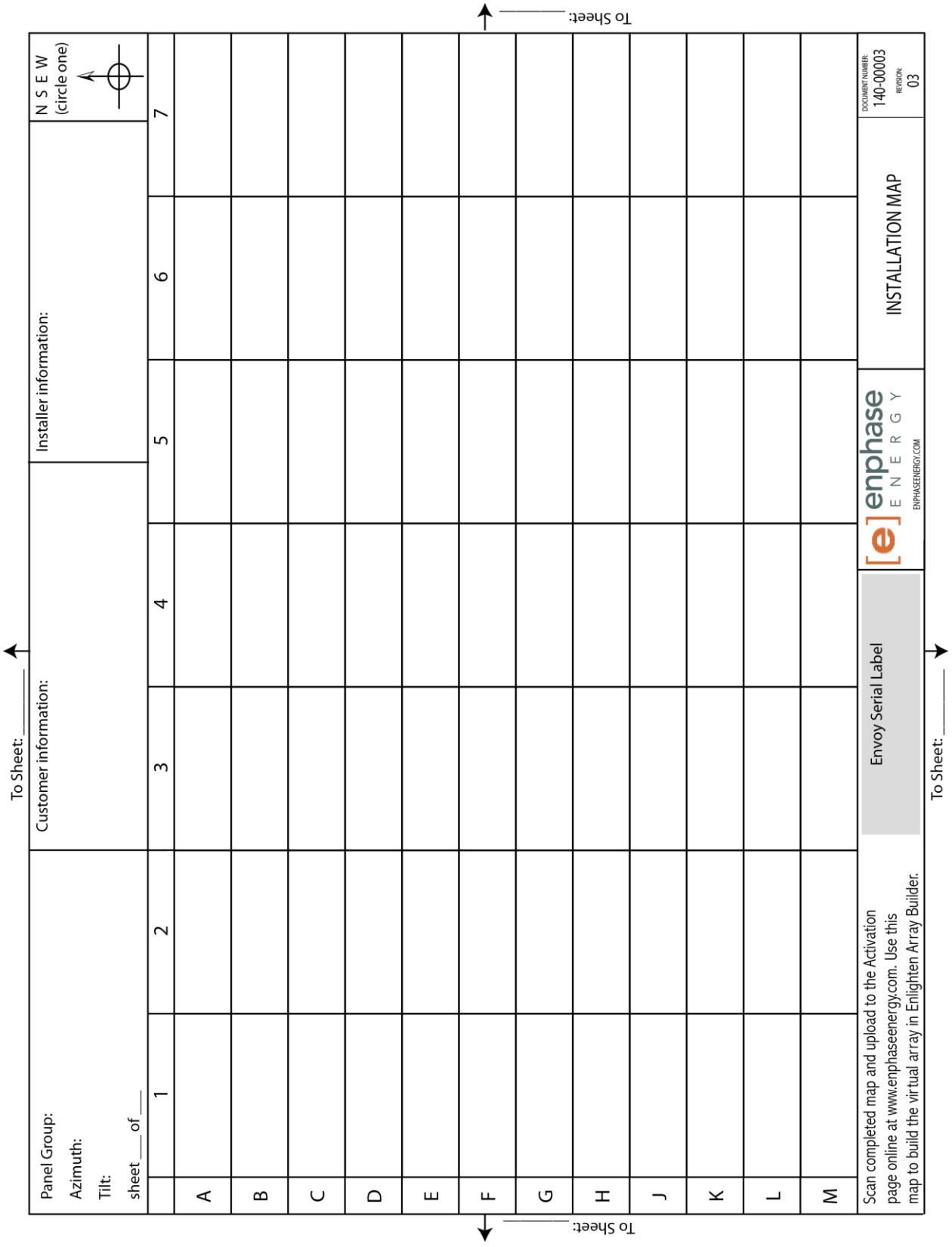
Enphase Installation Map



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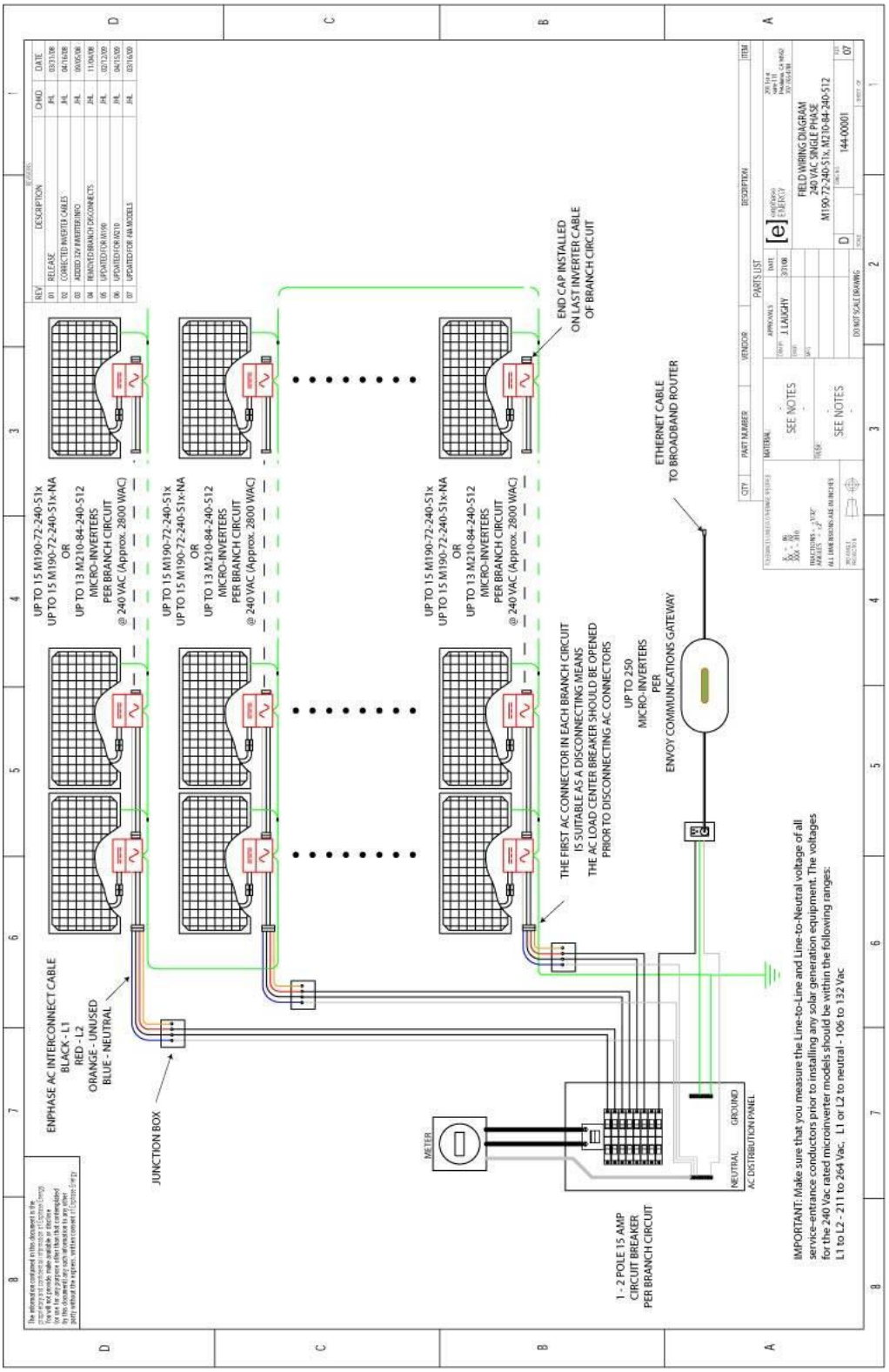
Sample Wiring Diagram, M190-72-240


UP TO 15 M190-72-240-51x
UP TO 15 M190-72-240-51x-NA
OR
UP TO 13 M210-84-240-512
MICRO-INVERTERS
PER BRANCH CIRCUIT
@ 240 VAC (Approx. 2800 WAC)
END CAP INSTALLED
ON LAST INVERTER CABLE
OF BRANCH CIRCUIT
ETHERNET CABLE
TO BROADBAND ROUTER
THE FIRST AC CONNECTOR IN EACH BRANCH CIRCUIT
IS SUITABLE AS A DISCONNECTING MEANS
THE AC LOAD CENTER BREAKER SHOULD BE OPENED
PRIOR TO DISCONNECTING AC CONNECTORS
UP TO 250
MICRO-INVERTERS
PER
ENVOY COMMUNICATIONS GATEWAY
ENPHASE AC INTERCONNECT CABLE
BLACK - L1
RED - L2
ORANGE - UNUSED
BLUE - NEUTRAL
JUNCTION BOX
METER
NEUTRAL
GROUND
AC DISTRIBUTION PANEL
1 - 2 POLE 15 AMP
CIRCUIT BREAKER
PER BRANCH CIRCUIT
IMPORTANT: Make sure that you measure the Line-to-Line and Line-to-Neutral voltage of all
service-entrance conductors prior to installing any solar generation equipment. The voltages
for the 240 Vac rated microinverter models should be within the following ranges:
L1 to L2 - 211 to 264 Vac, L1 or L2 to neutral - 106 to 132 Vac
FIELD WIRING DIAGRAM
240 VAC, SINGLE PHASE
M190-72-240-51x, M210-84-240-512
144-00001
SEE NOTES
SEE NOTES

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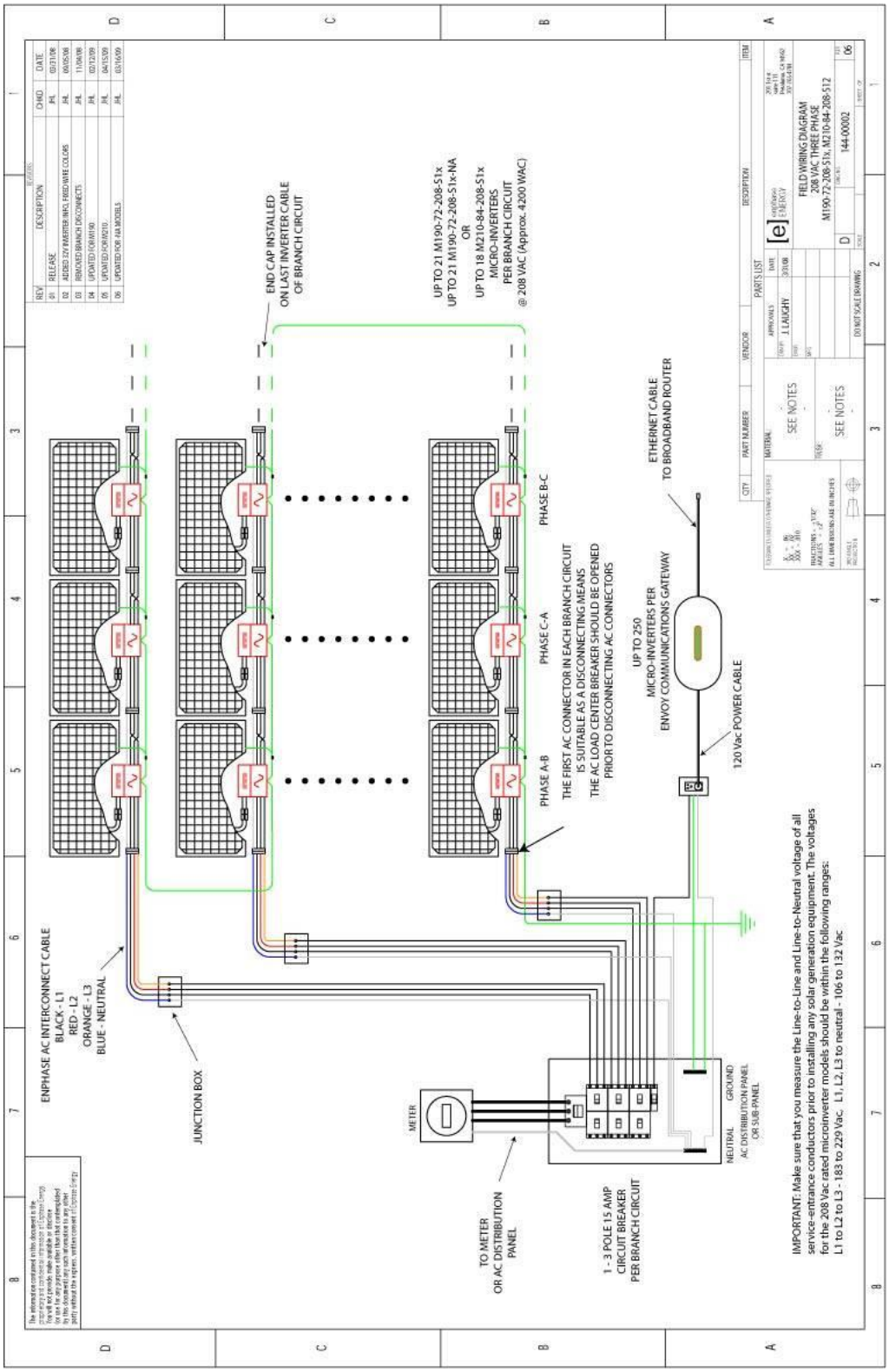
Sample Wiring Diagram, M190-72-208



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